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G1N NADP N1D6 N1D7 N1D7A N3V5

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(54) Touch signal probe

(57) A touch signal probe for detecting a displacement of a stylus 25 is provided on a supporting member 23 which is continuously urged to a casing 21 by weak coil springs 27. A non-contacting type displacement detecting device 41 detects an attitude change of the supporting member. As shown, a ferrite magnet 43 co-operates with a magnetic displacement detecting device 41 and displacement signals are fed to a calculating apparatus having an alarm and a memory. In Fig 3 (not shown) a supersonic displacement detecting device (55) is employed and consists of a supersonic sending and receiving device 54. In Figs 4 & 5 (not shown) optical displacement detecting devices (63, 75) are employed consisting respectively of a light, mirror and receiver (61, 23A, 62) and light, transparent marked roof plate and receiver (72, 73, 74). In Figs 7 & 8 (not shown) electrical displacement detecting devices (121, 131) are employed consisting respectively of a piezoeelectric actuator (124) and a magnet and coil (132, 133).

FIG. 2

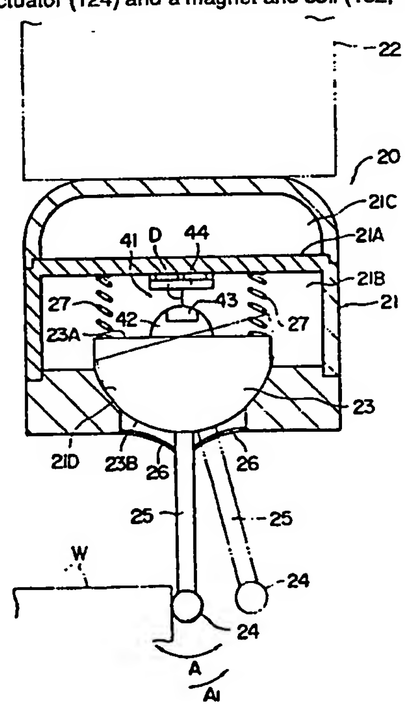

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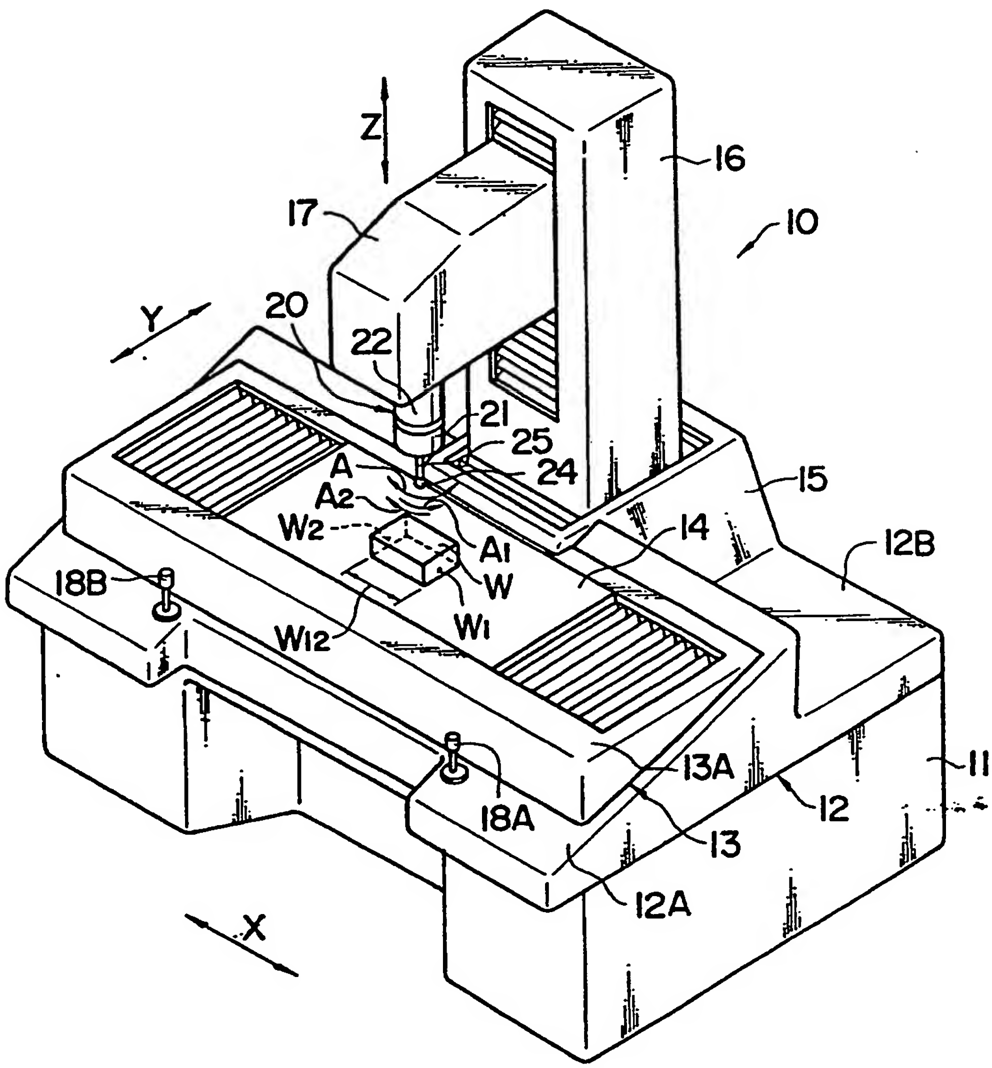
FIG. 1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10
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21
25
A
24
A2
15
W2
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12B
W
18B
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W12
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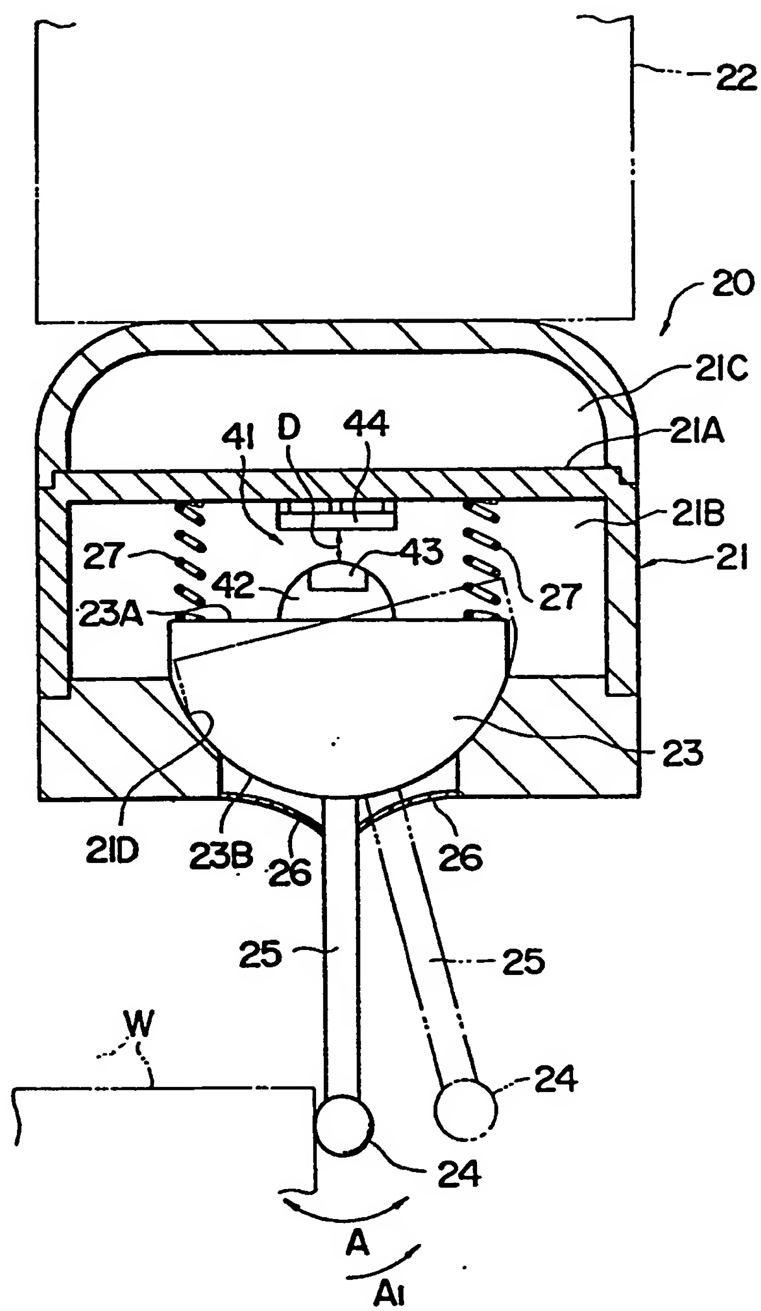
11
12
18A
13
12A
X

FIG. 2



22
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21C
21A
21B
21
41
D
44
43
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21D
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W
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24
A
A1

F I G. 3

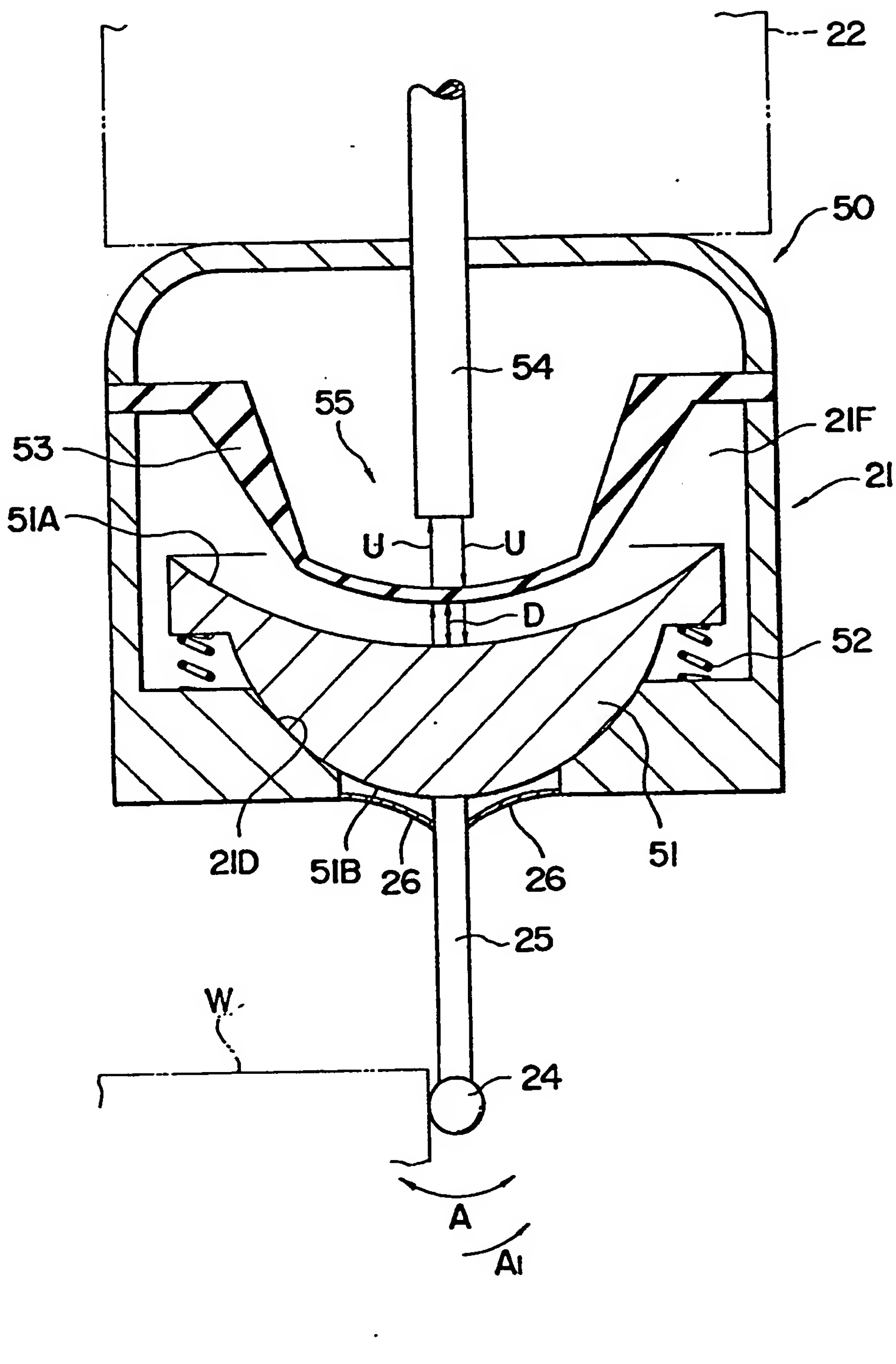


FIG.4

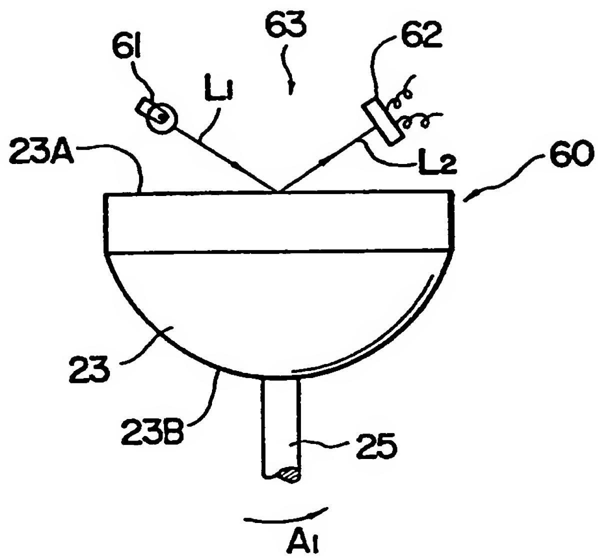


FIG.5

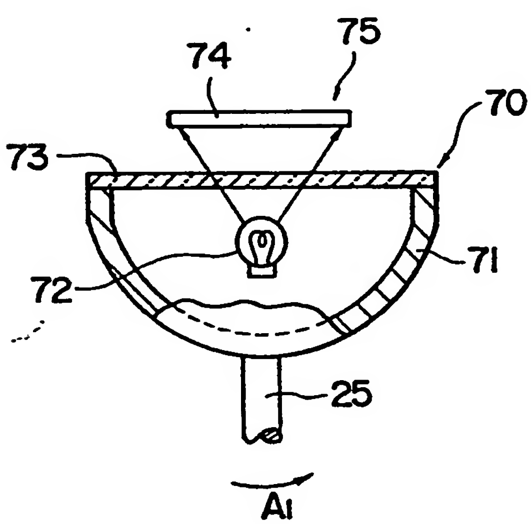
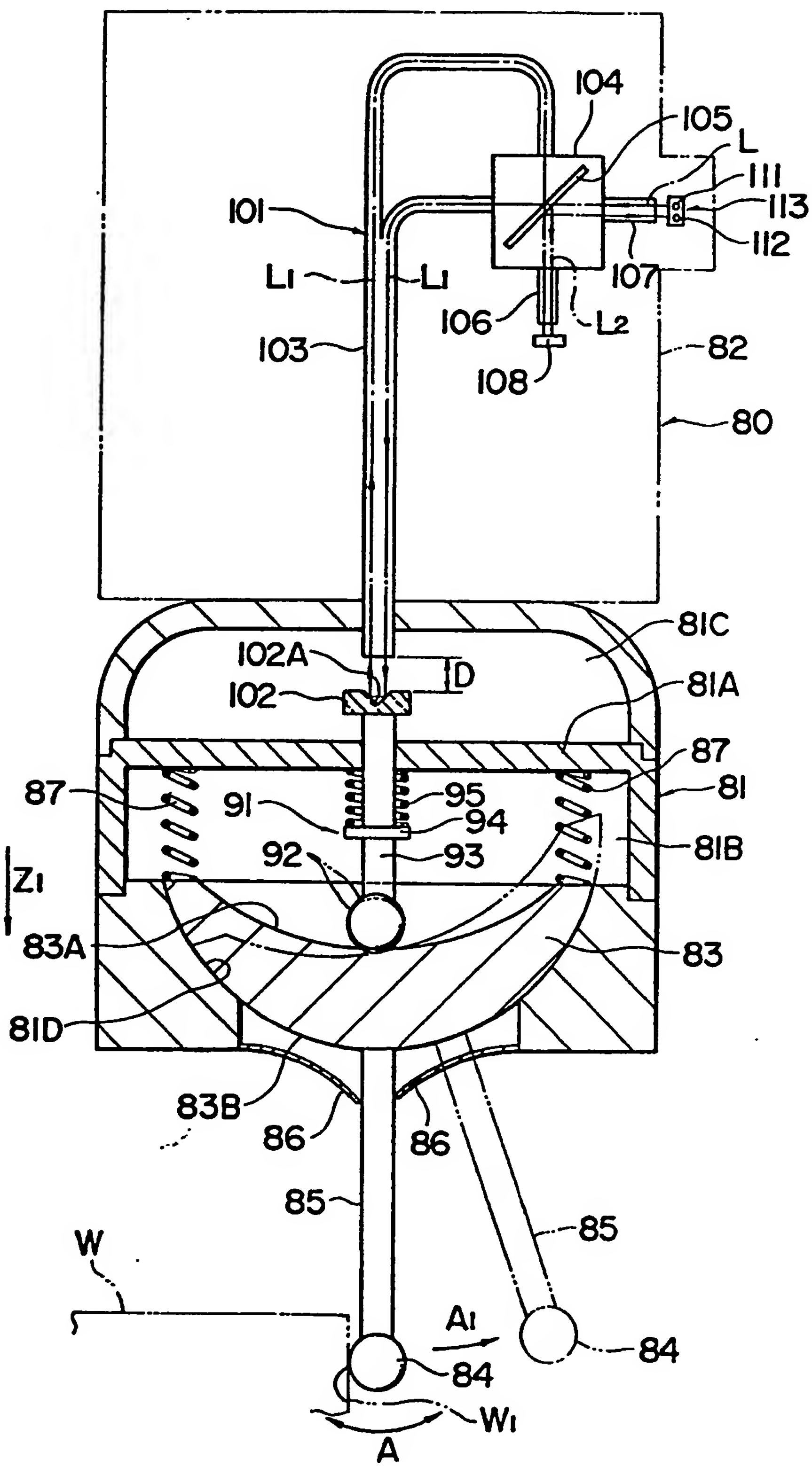


FIG. 6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L1
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91
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81B
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85
85
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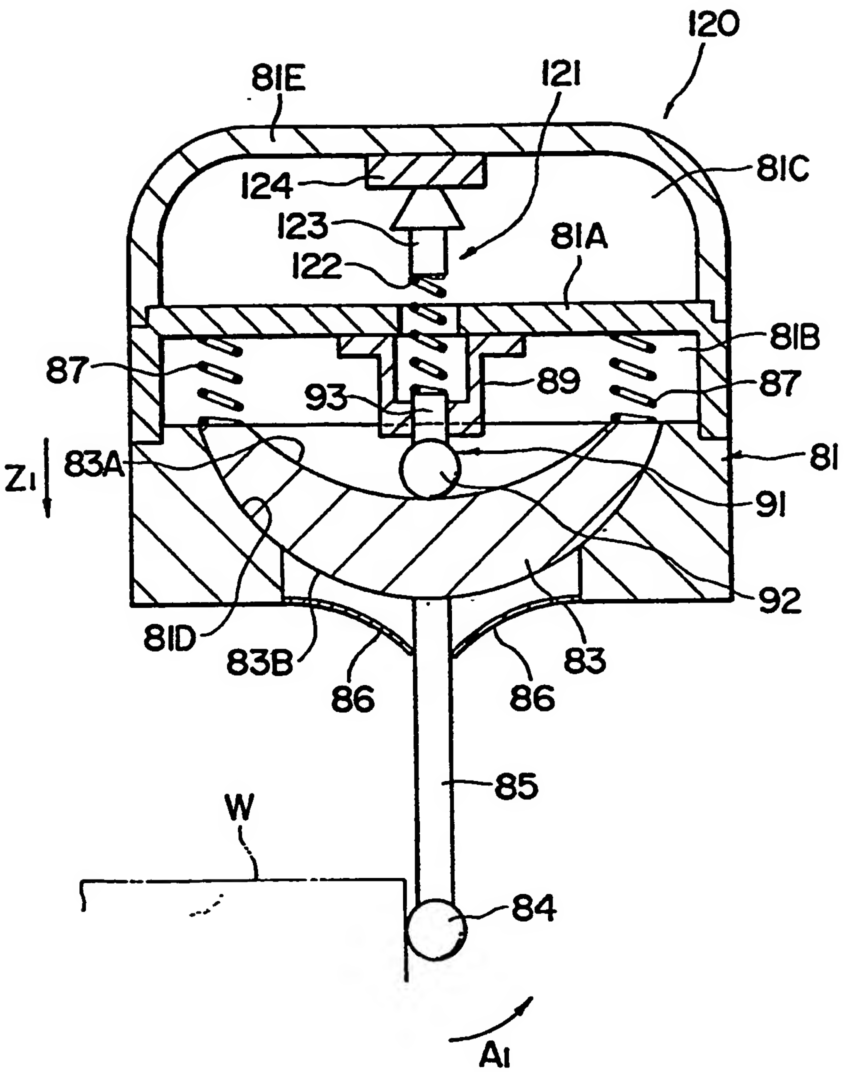
A1
84
84
W1
A

FIG. 7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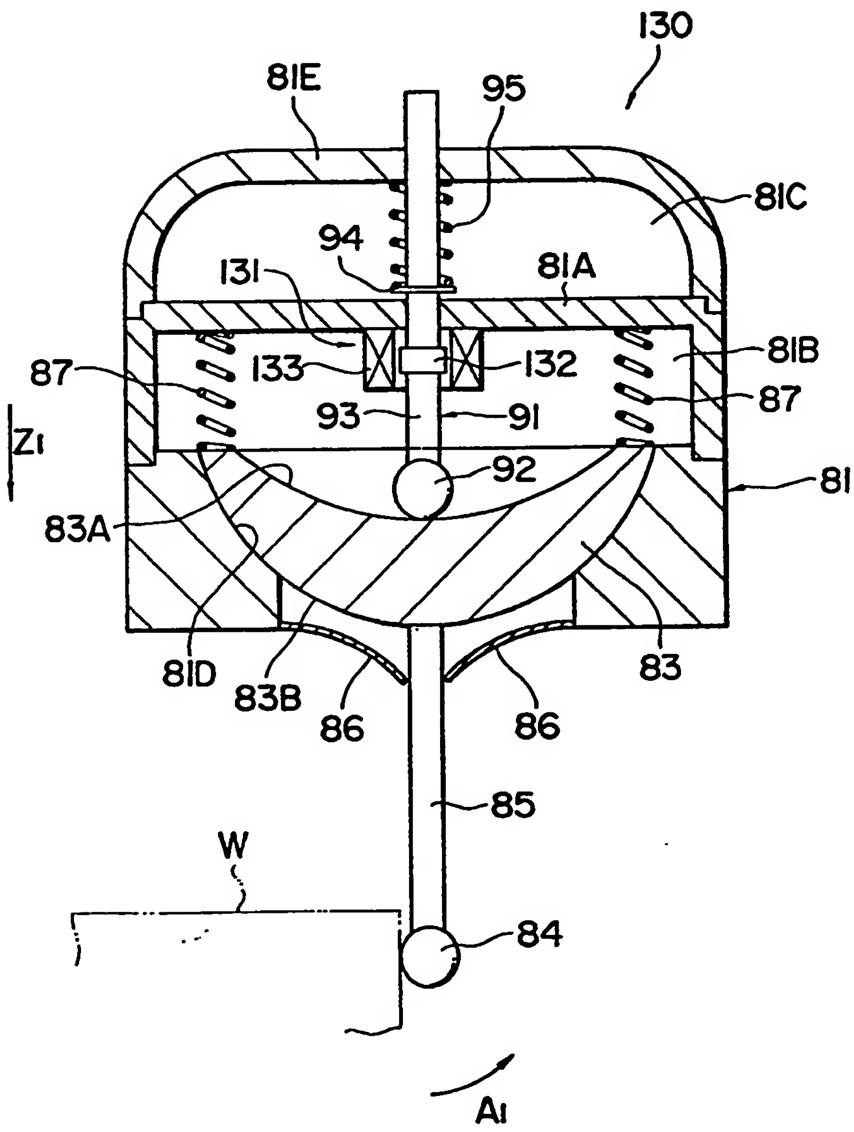
W
84
A1

FIG. 8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81
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83
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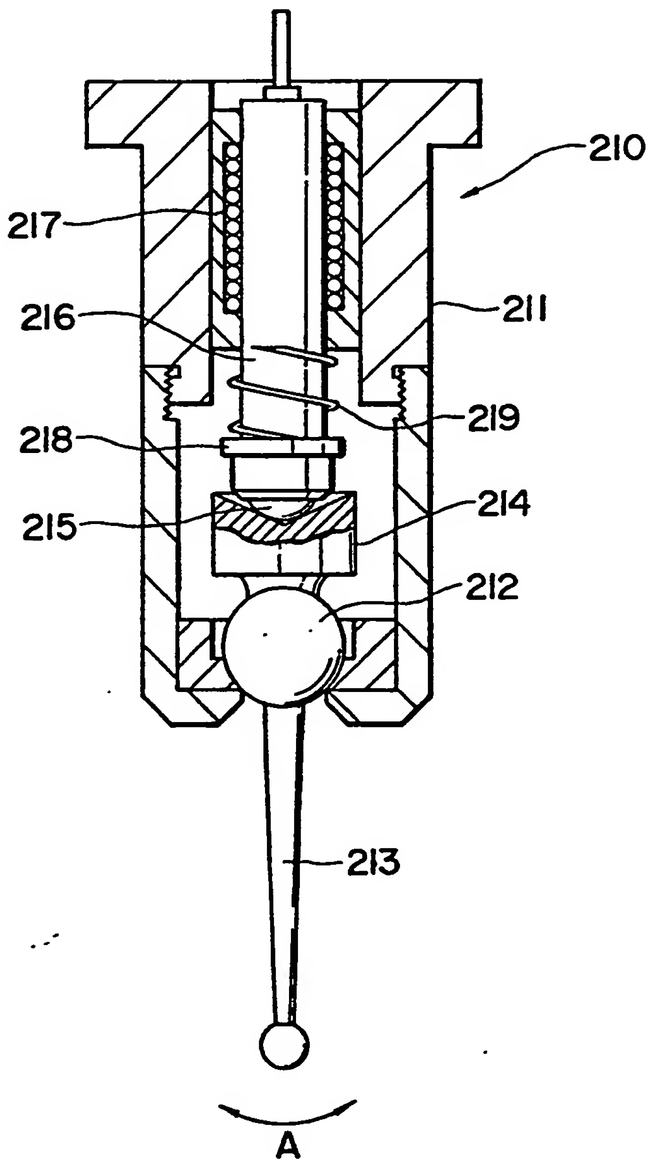
W
84
A1

FIG. 9



TOUCH SIGNAL PROBE

This invention relates to a touch signal probe, particularly to a sophisticated touch signal probe which may be adapted to a Z-slider extended to the vertical direction of a three-dimensional or two-dimensional measuring instrument such as a coordinate measuring instrument or to a main axle of a machine tool and thereby able to detect an abutting position against an object to be measured.

A various kinds of coordinate measuring instruments are broadly used as to be an apparatus for measuring dimensions, shapes and the like of the object to be measured. A touch signal probe, which issues a detecting signal when abutting against the object, is ordinary used for precise measurement of the object by such a coordinate measuring instrument. Many types of the touch signal probes have been conceived so far, for example, a technical idea of the touch signal probe can be learned from one prior technique, a National publication of translated version No.58-501690, and details of which is shown in Fig. 9.

In Fig. 9, a probe 210 includes a casing 211 and a sphere 212 which is h ld in a bottom portion of the casing 211 and capable of displacing toward the direction of an arrow A. The

sph re 212 is provid d with a stylus, for abutting against an object to be measured (not shown), at a lower portion thereof and further provided integrally with a supporting member 214 of which upper surface is formed to have a recessed portion having a cone section. The recessed portion of the supporting member 214 engages with a semi-sphere 215 which is integrally provided with a movable element 216 having a rod shape capable of sliding into a direction of its axis through a ball bush bearing 217 in the casing 211. The movable element 216 has a rib portion 218 integrally and, on its outer periphery, a coil spring 219 for pressing between the rib portion 218 and the casing 211.

In an operation for a displacement measurement of the stylus 213 by such touch signal probe 210, the stylus 213 is abutted against the object to be measured at first. The stylus 213 is then swung along the arrow A direction, while the supporting member 214 fluctuates toward the opposite direction.

Besides, the movable element 216 is displaced to a vertical direction against the pressure of the coil spring 219 and thereby displacement of which can be detected by a displacement detecting apparatus not shown for detecting the swing of the stylus 213.

However, when swing the stylus 213 into the arrow A, it is necessary to give a bigger load to the stylus 213 than the pressure issued by the coil spring 219 to deflect the coil spring 219 r displac th movabl lement 216 into the vertical dir ction.

When giving a bigg r load than th pr ssur of th coil spring 219 to the stylus 213, the stylus 213 is slightly deflected as to exceed over the pressure of the coil spring 219 and thereby a displacement value of which becomes small. Therefore it is difficult to precisely measure the objects owing to the measuring error. This is because the supporting member 214 contacts with the semi-sphere 215 of the movable element 216 and a urging force of the coil spring 219 is applied to the sphere 212 when detecting the slight displacement of the stylus 213.

An object of the present invention is to provide a touch signal probe without a big force for a displacement of a stylus, whereby a measuring error can be solved due to a deflection of the stylus.

The present invention is conceived through a recognition that when a stylus in a conventional touch signal probe is displaced, it needs for the stylus to be applied a bigger force than the pressure of the movable element toward the supporting member whereby a deflection of the stylus comes out. The above-mentioned object can be achieved by decreasing or disappearing the urging force of an urging structure such as having a spring toward the supporting member being integrally fluctuated with the stylus.

According to a preferable mbodiment of th invention, the touch signal pr be includ s: a casing; a supporting member f

which out r circumferential surfac is formed into a circl , the supporting member being provided as to fluctuate in the casing; a stylus mounted on the outer circumferential surface of the supporting member so that a forward end portion of the stylus is projected out of the casing for abutting against an object to be measured; a means for urging the supporting member to continually abut the outer circumferential surface of the supporting member against the casing; a means for decreasing an urging force issued by the means for urging the supporting member, while the stylus is fluctuated; and a displacement detecting means for detecting an attitude change of the supporting member.

The means for decreasing the urging force is so provided that the displacement detecting device is a non-contacting type displacement detecting device for detecting a fluctuation of the supporting member without coming into contact therewith. A non-contacting type displacement detecting device may be a magnetic displacement detecting device for detecting a change of a magnetic flux density, a supersonic displacement detecting device which includes a diaphragm and a supersonic sending and receiving device for oscillation of the diaphragm, or an optical displacement detecting device which includes a light source and a light receiving device for receiving a reflected light of the light irradiated from the light source.

In an operation of the touch signal probe having such a displac ment detecting device, it is expected to firstly attach th casing to an instrument such as Z-slider of a coordinate

m asuring instrum nt and subsequ ntly to abut the stylus against the object to be measured, whereby the supporting member supporting the stylus is swung in the casing because of the displacement of the stylus. This displacement of the stylus can be detected by the displacement detecting device which does not contact with the supporting member. In this end, there are no urging force from the displacement detecting device under the swing motion of the supporting member and a urging force against the casing ,by the means for urging the supporting member, can be minimized. Hence, a force applied to the stylus when abutting against the object to be measured is enough to be small and furthermore the stylus or the supporting member can be swung with no deflection of the stylus.

An another preferable embodiment of the means for decreasing the urging force includes a supporting member having a characteristic inner circumferential surface and a movable element urged against the surface of the supporting member by a means for urging the supporting member, so that an axial displacement of the movable element can be detected by a displacement detecting device.

The inner circumferential surface of the supporting member has a different curvature from that of the outer circumferential surface of the supporting member such as to have a crescent section, so that when the stylus is placed at a reference place, a place at which the movable element abuts against the inner circumferential surface of th supporting member is the most distant place from the out r circumferential surface of

th supporting memb r whereby the means for urging the movable element is deflected most, and when the stylus is fluctuated from the reference point owing to abutting against the object to be measured, a place at which the movable element abuts the inner circumferential surface of the supporting member is close to the outer circumferential surface of the supporting member.

A displacement detecting device, which detects an axial displacement of the movable element for measuring an attitude change of the supporting member, may be an optical displacement detecting device provided with a optical fiber, an electrical displacement detecting device including a piezoelectric actuator, or an electrical displacement detecting device having a differential transformer.

In an operation of the touch signal probe having such a displacement detecting device, it is expected to firstly attach the casing to an instrument such as Z-slider of a coordinate measuring instrument and subsequently to abut the stylus against the object to be measured, whereby the supporting member supporting the stylus is swung in the casing because of the displacement of the stylus. The movable element abutted against the inner circumferential surface of the supporting member is displaced into its axial direction. In this end, one end portion of the movable element comes up to the outer circumferential surface to the supporting member owing to the different surface shape between the inner and outer circumferential surfaces and th refore such an structure makes the urging force of th means for urging the movable element small.

Hence, the force applied to the stylus is made in small and thereby solve the occurrence of the deflection of the stylus or swing the stylus and the supporting member in a good manner.

The axial displacement of the movable element, while the supporting member swinging, can be detected by the displacement detecting device so as to detect the abutment of the stylus and the object to be measured.

In the accompanying drawings:-

Fig. 1 is a perspective view showing the first embodiment in which a touch signal probe of the present invention is applied to a coordinate measuring instrument.

Fig. 2 is a fragmentary sectional view, showing a general construction of the first embodiment.

Fig. 3 is a fragmentary sectional view of the second embodiment of the present invention.

Figs. 4 and 5 each is a schematic representation, showing a principle of the third or the fourth embodiments in the present invention.

Fig. 6 is a fragmentary sectional view, showing a general construction of the fifth embodiment.

Figs. 7 and 8 each is a fragmentary sectional view, showing a general construction of the sixth or the seventh embodiment in the present invention.

Fig. 9 is a sectional view of a construction of a conventional touch signal probe.

The preferred embodiments of a touch signal probe accorded to the present invention are described in detail with reference to the attached drawings.

Through Figs. 1 to 5, four embodiments which each has a means for decreasing an urging force will described in due course, the means being to include a non-contacting type displacement detecting device and a means for urging a supporting member with a weak force.

In Fig. 1, denoted at 10 is a coordinate measuring instrument applied with a touch signal probe 20 accorded to the first embodiment of the present invention. The coordinate measuring instrument 10 has a base 11 settled on a floor and an object mounting table 12 having a tilted portion 12A and a flat portion 12B on the base 11. The tilted portion 12A is provided thereon with a supporting table 13 having an upper surface 13A nearly parallel to the floor. The supporting table 13 contains therein a X-slider 14 which displaces an object to be measured to the direction of an arrow X extending horizontally by an air-bearing (not shown), the object being to be mounted on the X-slider 14 and to be in a rectangular parallelopiped shape.

The flat portion 12B integrally has a mount 15 in a trapezoidal shape therewith and a Y-slider 16 is provided on the mount 15 as move into an arrow Y on a horizontal surface perpendicular to the X-direction by an air-bearing (not shown). Th Y-slid r 16 is constructed with a Z-slider 17 movable into a v rtical arrow Z directi n by an air-b aring (not shown). A

touch signal probe 20 of the present invention is detachably connected to the forwarded end portion of the Z-slider 17.

There are joy sticks 18A and 18B on the tilted portion 12A of the object mount table 12. When controlling the joy stick 18A to the arrow X direction, the X-slider 14 correspondingly moves to the arrow X direction. While controlling the joy stick 18A to the arrow Y direction, the Y-slider 16 correspondingly moves to the arrow Y direction. And, when controlling the joy stick 18B to the arrow X direction, the Z-slider 17 correspondingly moves to the arrow Z direction.

The probe 20 has a casing 21 and a cylindrical member 22 disposed on the casing 21. The casing 21 is divided into two portions, a lower space 21B and a upper space 21C, by a parting plate 21A.

In the lower space 21B, a supporting member 23 in a semi-sphere shape is provided as an outer circumferential surface 23B thereof slides on a spherical surface 21D of the casing 21 along the direction of an arrow A. The supporting member 23 has ,at its bottom portion, a stylus 25 which has a sphere 24 at its end portion and a forward portion of which is out of the casing 21. In order to secure the backward portion of the stylus 25 from a dust and to prevent the rotation of the stylus 25, a relatively hard diaphragm 26 is provided on the casing 21. The diaphragm 26 is, for example, so constructed that a plurality of thin plasticplates each having a fan shape are laminat d on the top of each other such as a diaphragm employ d in a camera.

S m of w ak coil springs 27 ar intermediately pr vid d between a peripheral portion of a upper surface 23A in flat shape of the supporting member 23 and a lower surface of the parting plate 21A. In Fig. 2 drawn by a full line, a reference position of the stylus 25 can be settled at its stop position by the coil spring 27 as means for urging the supporting member, under a condition in which the stylus 25 is not to be abutted against or just touches the object W with no displacement.

A non-contacting type magnetic displacement detecting device 41 is provided at almost center portion of the upper surface of the supporting member 23 and at the central portion of the parting plate 21A for detecting a slight displacement of the stylus 25. The magnetic displacement detecting device 41 comprises a semi-sphere 42 fixedly mounted on the supporting member 23, the semi-sphere 42 being to have a ferrite magnet 43 at its top portion capable of issuing a magnetic force toward its upper direction, and a hall IC 44 disposed at the lower surface of the parting plate 21A for receiving an issued magnetic force from the ferrite magnet 43 and subsequently converting it into a current. The magnetic displacement detecting device 41 is constructed with the semi-sphere 42 and the hall IC 44.

A means for decreasing the urging force is constructed with the non-contacting type magnetic displacement detecting d vice 41 and the coil spring 27 as means for urging the supporting memb r 23 with a w ak force.

Th coordinat measuring instrument 10 accord d t th present invention is primarily constructed as mentioned before. The operation of it will be described hereunder.

Supposing a measurement of the object W on its dimensions and shapes, it needs to be moved respectively for the X-slider 14, the Y-slider 16, and the Z-slider 17 by controlling the joy sticks 18A and 18B in order to shift the sphere 24 as to abut against the certain point W1 of the object W, whereby the stylus 25 fluctuates along the arrow A1 direction and the supporting member 23 is correspondingly moved.

This follows that when the supporting member 23 moves into the A1 direction, the ferrite magnet 43 provided in the semi-sphere 42 on the supporting member 23 is also swung, that is the received magnetic force in the hall IC 44 is naturally varied. The vary is followingly input to a calculating apparatus as showing a displacement of the stylus 25, issuing an alarm. The disposition, into the X direction, of the sphere 24 provided at the end portion of the stylus 25 is memorized in a calculating means.

Secondly, it needs to be controlled for the sphere 24 to shift at and abut against another point W2 on the object W by controlling the joy stick 18A and 18B, and, as already mentioned, the disposition into the X direction of the sphere 24 is memorized in the same calculating means. Hence, one side dimension W12 of the object W can be measured by the calculating means.

As has described, other sid s dim nsions of the bject W

can be m asured in the same way, wh r by all of th dim nsions and the shapes of the object W can be measured.

Some effects of this embodiment are recognized as follows.

When the sphere 24 of the stylus 25 is swung due to abutting at the certain point (W1,W2) of the object to be measured W, a slight displacement of the stylus 25 is to be detected by the magnetic displacement detecting device 41. This is that there is no need of the urging force for the displacement detecting device 41, and the urging force of the coil spring 27 as means for urging the supporting member 23 is enough to be a slight force to urge the supporting member 23 to the casing 21. The means for decreasing the urging force, including the non-contacting type displacement detecting device 41 and the coil spring 27 as the means for urging the supporting member 23 with a slight force, can decrease a big urging force of the coil spring toward the stylus 25 as in the conventional structure and thereby prevent a deflection of the stylus 25, whereby it can be expected to precisely detect any small displacement of the stylus 25 in an event of the high accurate measurement. Besides, each element of the structure is simple in its shape and therefore in easy for producing in a cheaper price.

The magnet 43 is disposed on the semi-sphere 42, so that while the stylus 25 is fluctuated to the arrow A direction, the predetermined distance D is always kept in constant, being useful to issue a constant magnetic force from the magnet 43, wh r by the accurate m asur ment by the coordinate measuring instrum nt 10 can be xpect d.

Such a modificati n may be employed that the hall IC 44 is arranged on its shape and characteristic to measure a movement of and a variation of an axial displacement of the stylus 25.

With reference to Fig. 3, the second embodiment of the present invention is described as follows. Incidentally, in the description of the following embodiment, the same reference numerals will be used to designate the same or similar components as those in the first embodiment, so that some of descriptions will be omitted or simplified.

A touch signal probe 50 accorded to the second embodiment includes a casing 21 consisting of a divided space 21F. The space 21F includes, in its lower portion, a supporting member 51 in a shape of a nearly semi-sphere as to be capable of moving into the direction of an arrow A. The supporting member 51 is supported by a spherical surface 21D of the casing 21 at its outer circumferential surface 51B. A coil spring 52 for stretching the supporting member 51 with a slight force as a means for urging the supporting member 51 is provided between the supporting member 51 and the lower portion of the space 21F.

An upper surface of the supporting member 51 or an inner circumferential surface 51A is a larger curvature than an outer circumferential surface 51B. At an upper side of a distance D, for example some mm, from the inner circumferential surface 51A, a diaphragm 53 is provided, which has a corresponding shapes to the inner circumfer ntial surface 51A and is formed to have a fac with a thickness of some mm at its c nter. Th

diaphragm 53 separately c upl d with a supersonic s nding and receiving device 54 for issuing a supersonic U at its upper side. The sending and receiving device 54 and the diaphragm 53 compose a non-contacting type supersonic displacement detecting device 55.

The supersonic displacement detecting device 55 and the coil spring 52 as the means for urging the supporting member 51 comprise a means for decreasing the urging force toward the member 51.

Accordingly, when the sphere 24 abuts against the object W, the stylus 25 is correspondingly moved toward the arrow A1 direction, whereby the supporting member 51 is simultaneously displaced into the direction of the arrow A1 as to change the predetermined distance D. Hence, the oscillation of the diaphragm is deviated, and a small fluctuation of the stylus 25 can be detected by the supersonic displacement detecting device 55.

It is of course that the same effects can be attained as in the first embodiment.

Fig. 4 shows the third embodiment of the present invention. Incidentally, in the description of the following embodiment, the same reference numerals will be used to designate the same or similar components as those in the first embodiment, so that some of descriptions will be omitted or simplified.

A touch signal probe 60 in this third embodiment differs from that in the first mbodiment in a displacement detecting d vice.

That is, in Fig. 4, the upper surface 23A of the inner surface of the stylus 23 is manufactured as a mirror, and a light source 61 for angularly irradiating a light L1 to the surface 23A is disposed at an upper side of the surface 23A. At an opposite side of the light source 61, there is provided with a receiver 62 comprising a light receiving element such as a photodiode, photodiode-array, CCD, and the like. The light source 61 and the receiver 62 compose an optical displacement detecting device 63 as a non-contacting type displacement detecting device.

As has been constructed, when the stylus 25 is slightly displaced into the direction of the arrow A1 direction, the upper surface 23A is somewhat tilted angularly in response thereto. The lighting angle of the reflected light L2 which is originally irradiated from the light source 61 and subsequently reflected on the surface 23A is therefore changed. The receiver 62 then detects the change of some quantity of reflected light L2 and thereby detects a small displacement of the stylus 25.

It is obvious that the same effects can be obtained as in the first embodiment.

In Fig. 5, the fourth embodiment of the present invention is essentially described.

A touch signal probe 70 in the fourth embodiment includes a supporting member 71 which is of a semi-sphere shape and have a hollow portion in its inside, a light source 72 in the supporting member 71, and a roof plate 73 which is a translucent cover of the supporting member 71. The upp r surface of th

roof plat 73 is printed on a concentric circle or a division. There is provided with a light receiving plate 74, such as the CCD, at a predetermined distant place from the roof plate 73. The light source 72, the roof plate 73, and the light receiving plate 74 comprise a non-contacting optical displacement detecting device 75.

According to such a construction, when the stylus 25 and the supporting member 71 are slightly tilted together, the quality of receiving light at the light receiving plate 74 from the light source 72 through the roof plate 73 is changed by the division drawn on the surface of the roof plate 73. Hence, a small fluctuation of the stylus 25 can be detected by the optical displacement detecting device 75. In this end, some of fixed division may be drawn on a surface under the light receiving plate 74 or opposite to the roof plate 73.

This may achieve almost the same effects as by the mentioned embodiments.

So far, though some of preferable embodiment, each which employs a non-contacting type displacement detecting device, in the present invention are described, the invention will not be limited to those embodiments and may be arranged and modified as aim the same subject matter of the present invention.

Taking for some instances, the shape of the semi-sphere 42 integrally provided with the supporting member 23 and the ferrite magnet 43 are not only to be limited to a semi-sphere as in the aforesaid embodiments, but also to be in flat shapes or some th r shapes as to issu a magnetic flux toward th hall

IC 44. H wev r, if their shap s ach is to b s mi-sph r , the above effects can be achieved.

The means for urging the supporting member is not limited to the coil springs 35 and 52, but also a flat spring and so on.

The displacement detecting device may be an electrical displacement detecting device capable of detecting a change of a electric capacity as a non-contacting type displacement detecting device.

From Figs. 6 to 8, three embodiments of the present invention which each employs therein a means for decreasing a urging force having a characteristically shaped supporting member.

The fifth embodiment of the present invention is shown in Fig. 6.

A touch signal probe 80 in this embodiment includes a casing 81, a case holder 82 stationary disposed on the casing 81, the casing 81 being divided into a lower space 81B and an upper space 81C by a parting plate 81A.

The lower space 81B involves therein a supporting member 83 which is formed into have a crescent section as to be swung into an arrow A direction along a spherical surface 81D of the casing 81. Each surface of the supporting member 83 is formed into a circumference. A curvature of an inner circumferential surface 83A of the supporting member 83 is different from that of the outer circumferential surface 83B. Details on this point will be d scribed in the followings, however, the inner circum-

ferential surfac 83A of the supp rting member 83 is primarily of a bigger radius than that of the outer circumferential surface 83B.

The supporting member 83 has, at its lower portion, a stylus 85 which has a sphere 84 at its forwarded end portion and is projected from the casing 81. In order to secure the backward portion of the stylus 85 from a dust and to prevent the rotation of the stylus 85, a relatively hard diaphragm 86 is provided on the casing 81. The diaphragm 86 is, for example, so constructed that a plurality of thin plasticplates each having a fan shape are laminated on the top of each other such as a diaphragm employed in a camera.

Some of weak coil springs 8 are intermediately provided between a peripheral portion of a upper surface of the supporting member 83 and a lower surface of the parting plate 81A. In Fig. 6 drawn by a full line, a reference position of the stylus 85 can be settled at its stop position by the coil spring 87 as means for urging the supporting member, under a condition in which the stylus 85 is not to be abutted against or just touches the object W with no displacement.

A movable element 91 is provided at almost center portion of the supporting member 83 for converting a small swing displacement of the stylus 85 into a vertical displacement. The movable element 91 includes a sphere 92 for abutting against the inner circumferential surface 83A of the stylus 83. The spher 92 is fixed to a rod 93 which is guid d by the parting plate 81A of th casing 81 as to move int its vertical direc-

tion. Th rod 93 has a circular plate 94 at its central portion and a coil spring 95 is provided, between the circular plate 94 and the parting plate 81A, for giving a weak pressure as a means for urging the movable element.

On an upper side of the rod 93, an optical displacement detecting device 101 is provided as a non-contacting type displacement detecting device for detecting a vertical displacement of the movable element 91. The displacement detecting device 101 is mounted at the upper side of the rod 93 and includes a reflection mirror 102 which has a V-shaped notch portion 102A thereon and an optical fiber 103 of which one end is separated with a distance D from the reflection mirror 102, and extending into the case holder 82. The optical fiber is divided into two ways and respectively connected with an upper side and an left side of a mirror box 104. The mirror box 104 includes a half-mirror 105 which is disposed angularly at tilts of predetermined degrees, for example of 45 degrees and further includes other optical fibers 106 and 107 respectively provided at the lower side and the right side of the mirror box 104.

A total reflection mirror 108 is provided distantly at a predetermined intervals from the optical fiber 106. A lighting and receiving means 113, which includes a lighting device 111 irradiating a light L and a light receiver 112 for inputting the light L transmitted through predetermined ways and subsequently outputting its signal to a calculating means (not shown), is provided at a certainly extended position from the optical fiber 107. Some of memb rs, which are provided on a way

from th reflection mirror 102 t the lighting and receiving means 113, compose an optical displacement detecting means 101.

Incidentally, the shape of the inner circumferential surface 83A of the supporting member 83 is formed so mentioned above that its radius is bigger than that of the outer circumferential surface 83B. In particular, the shape of the inner circumferential surface 83A is so arranged in Fig. 6 with a full line that when the stylus 85 is placed at the reference position, a place at which the sphere 92 of the movable element 91 abuts against the inner circumferential surface of the supporting member 83 is the most distant place from the outer circumferential surface 83B of the supporting member 83 whereby the coil spring 95 as the means for urging the movable element is deflected most, and when the stylus 85 is fluctuated to any direction (arrow A direction) owing to abutting against the object to be measured, a place at which the movable element 91 abuts the inner circumferential surface 83A of the supporting member 83 is close to the outer circumferential surface 83B of the supporting member 83. Therefore, when the stylus 85 or the supporting member 83 is fluctuated into any direction, the movable element 91 is always to be moved lower direction (an arrow Z1 direction) as to stretch the coil spring 95, that is shown by a two-dot-chain line in Fig. 6.

Incidentally, the inner circumferential surface 83A of the supporting member 83, the coil spring 87 as the means for urging the supporting member 83 with a slight urging force, the movable elem nt 93, the coil spring 95 as the means for urging

the movabl el m nt 95, and th optical displac ment detecting device 110 comprise the means for decreasing the urging force.

The coordinate measuring instrument 10 accorded to the instant embodiment is fundamentally constructed as mentioned-before. The followings are its operation.

When measuring the dimensions and the shapes of the object W to be measured, it is expected to irradiate the light L from the lighting device 111 of the lighting and receiving means 113, at first. The light L is, therefore, passed through the optical fiber 107, subsequently divided into a transmitted light L1 and a reflected light L2. The reflected light L2 is firstly reflected by the total reflection mirror 108 and then reflected by the half-mirror 105 again, thereby input to the light receiver 112. In this end, though it may seem that the reflected light L2 is repeatedly returned to the lighting device 111 by reflecting at the half-mirror, it is indeed the fact arranging a position and size of the lighting device 111 or the light receiver 112 and controlling a shape and angle of the half-mirror in order to input the reflected light L2 into the light receiver 112.

While the transmitted light L1 is reflected at the reflection mirror 102 after issuing from the optical fiber 103, followingly input into the optical fiber 103 again, completely reflected by the total reflection mirror 108 through the half-mirror 105 in the mirror box 104, and finally input into the light rec iver 112 after being reflected at th half-mirror 105. In this moment, it is necessary to console a phas differ-

nce b tween th two optical signals in a not-shown calculating means as a square wave signal.

Next, as shown in Fig. 1, it needs to be moved respectively for the X-slider 14, the Y-slider 16, and the Z-slider 17 by controlling the joy sticks 18A and 18B as to abut the sphere 84 against the certain point W1 of the object W, whereby the stylus 85 fluctuates along the arrow A1 direction and the sphere 92 of the movable element 91 is correspondingly moved into the direction of an arrow Z1 direction as to slide on the inner circumferential surface 83A of the supporting member 83.

This follows that when the sphere 92 moves into the Z1 direction, the distance D between the upper surface of the reflection mirror 102 and the end of the optical fiber 103 is made to be long, changing the time intervals for inputting the transmitted light L1 into the light receiver 112. And a square wave signal having a face difference from the pre-consoled face difference is input to the calculating means, and thereby able to detect the displaçement of the stylus 85 and issue an alarm signal. The disposition, into the X direction, of the sphere 84 provided at the end portion of the stylus 85 is memorized in a calculating means.

Secondly, it needs to be controlled for the sphere 84 to shift at and abut against another point W2 on the object W by controlling the joy stick 18A and 18B. And, as already mentioned, it is necessary to detect the displacement of the stylus 85 into the A2 dir ction and memoriz its position of the X-dir ction at that time in the same calculating m ans.

Hence, ne sid dimension W12 of th object W can be m asur d by the calculating means.

As has described, other sides dimensions of the object W can be measured in the same way, whereby all of the dimensions and the shapes of the object W can be measured.

Some effects of this embodiment are recognized as follows.

When the sphere 84 of the stylus 85 is swung due to abutting at the certain point (W1, W2) of the object to be measured W, the sphere 92, which integrally provided with the stylus 85 and slides on the inner circumferential surface 83A of the supporting member 83 having the crescent section, easily moves into the arrow Z1 direction by the coil spring 95 as the means for urging the movable element. Besides, the stylus 85 is not to be forced by the coil spring 95 due to the characteristic shapes of the inner and outer circumferential surface 83A, 83B of the supporting member 83, whereby there are no deflections of the stylus 85. Therefore, it can be expected to precisely detect any small displacement of the sphere 92 in an event of the high accurate measurement. Besides, each element of the structure is simple in its shape and therefore in easy for producing in a cheaper price.

With reference to Fig. 7, the sixth embodiment of the present invention is described as follows. Incidentally, in the description of the following embodiment, the same reference numerals will be used to designate the same or similar components as those in the afor mentioned embodim nts, so that some of d scriptions will b omitt d or simplifi d.

A touch signal prob 120 in th sixth mbodiment differs from that in the fifth embodiment on the displacement detecting device for detecting the displacement of the stylus 85.

That is, in Fig. 7, a movable element 91 includes a sphere 92 abutting against the inner circumferential surface 83A. A rod 93 provided with the sphere 92 is supported by a bracket 89 which is projected from the parting plate 81A for its free movement along its axial direction. A electrical displacement detecting device 121, as a non-contacting type displacement detecting device, is provided on an upper side of the rod 93.

The electrical displacement detecting device 121 includes a rod 123 which is disposed on the upper end of the rod 93 with a coil spring 122 as a means for urging a movable member and a piezoelectric actuator 124 which abuts to the upper portion of the rod 123 and mounted on a roof portion 81E of the casing 81.

The inner circumferential surface 83A of the supporting member 83, the coil spring 87 and the movable element 91 as a means for urging the supporting member 83, and the electrical displacement detecting device 121 having a coil spring 122 as a means for urging the movable element 91 compose a means for decreasing an urging force.

In this structure, when the sphere 84 abuts against the object W to be measured, the stylus 85 correspondingly swing into the direction of an arrow A1. The sphere 92 is therefore displaced into an arrow Z1 direction, the pressure urged toward the piezo lectric actuator 124, and whereby the fluctuation of th stylus 85 can be detected.

In this end, such a structure do s not n d a optical fiber as in the aforementioned embodiment, so that it may achieve to make the probe 120 small in size and to attain the same effects as in the mentioned embodiment.

In Fig. 8, the seventh embodiment of the present invention is shown.

Incidentally, in the description of the following embodiment, the same reference numerals will be used to designate the same or similar components as those in the aforementioned embodiments, so that some of descriptions will be omitted or simplified.

A touch signal probe 130 in this embodiment also has a different displacement detecting device as in the sixth embodiment.

That is, in Fig. 8, the movable element 91 includes the sphere 92 capable to abutting the inner circumferential surface 83A, the sphere 92 being provided with the rod 93 which extends from the inside to the outside of the casing 81. The rod 93 has the circular plate 94 at the upper space 81C, the coil spring 95 as a means for urging the movable element 91 is placed between the circular plate 94 and the roof plate 81E of the casing 81, and the sphere 92 is to be continuously abutting against the inner circumferential surface 83A.

While in the lower space 81B, an electrical displacement detecting device 131 is provided as a non-contacting type displacement detecting devic for detecting the displac m nt of the movable lement 91. The electrical displac ment det cting

device 131 includes, at its b dy, a core 132 made of a magnet and a coil 133 which is placed on the parting plate 81A of the casing 81 as to be disposed around the core 132, as so called a differential-transformer type displacement detecting device.

In this embodiment, the inner circumferential surface 83A, the coil spring 87, and the electrical displacement detecting device 131 compose a means for decreasing an urging force.

Accordingly, when the sphere 84 is abutted against the object W to be measured, the stylus 85 is swung toward the direction of the arrow A1 and the sphere 92 of the movable element 91 and the rod 93 are moved into the arrow Z1 direction. This displacement is detected by the coil 133 of the displacement detecting device 131 and therefore the displacement of the stylus 85 can be detected.

The same effects in the fifth embodiment may be easily attained by this embodiment.

So far, in the fifth to seventh embodiments, some preferable embodiments, which each is equipped with a means for decreasing an urging force having a characteristic shape of the inner circumferential surface 83A of the supporting member 83 and the movable element 91, in the present invention are described, the invention will not be limited to those embodiments and may be arranged and modified as aim the same subject matter of the present invention.

Taking for some instances, the shape of the inner circumferential surfac 83A of the supporting member 83 is not limit- d to a sphere. as in each mbodim nt. It may be to hav a

parabolic s ction or anoth r s ction. After all, a plac wh r the sphere 92 as one end of the movable element 91 is abutted against the inner circumferential surface 83A when the stylus is placed at the reference position, is far from the outer circumferential surface 83B most and while fluctuated, come up to the outer circumferential surface 83B. But, if the sphere shape is employed, there is a merit on easy production.

The movable element 91 may not always have the sphere 92, but needs to be abutted against the inner circumferential surface 83A. This is because if being in spherical or convex, an easy slide on the inner circumferential surface 83A can be obtained.

The means for urging the movable element and the means for urging the supporting member are not limited into the coil springs 95 and 87, but also plate springs. The means for urging the supporting member needs not only to be provided individually but also to be combined with the means for urging the movable element.

The shapes of the casing 81, the stylus 85 and the like are also not to be limited as in the aforementioned embodiments.

The touch probe in the present invention can be applied to other measuring instruments except a coordinate measuring instrument, for example, to a machine toll and some machines.

Accordingly, such effects can be obtained that there are no defl ctions of the stylus and precise measurement through perati n of the measurement.

CLAIMS

(1) A touch signal probe comprising:

a casing;

a supporting member of which outer circumferential surface is formed into a circle, said supporting member being provided as to fluctuate in said casing;

a stylus mounted on the outer circumferential surface of said supporting member so that a forward end portion of said stylus is projected out of said casing for abutting against an object to be measured;

means for urging said supporting member to continually abut the outer circumferential surface of said supporting member against said casing;

and

displacement detecting means for detecting an attitude change of said supporting member.

(2) A touch signal probe according to claim 1, wherein said means for decreasing the urging force is so provided that said displacement detecting means is non-contacting type displacement detecting means for detecting a fluctuation of said supporting member without coming into contact therewith and the urging force issued by said means for urging said supporting member is made to be small.

(3) A touch signal probe according to claim 2, wherein said displacem nt det cting m ans is magnetic displacement detecting

means for detecting a chang of a magnetic flux density.

(4) A touch signal probe according to claim 2, wherein said displacement detecting means is supersonic displacement detecting means which includes; a diaphragm correspondingly disposed at predetermined intervals from an inner circumferential surface formed on said supporting member; and supersonic sending and receiving means for oscillation of the diaphragm.

(5) A touch signal probe according to claim 2, wherein said displacement detecting means is optical displacement detecting means which includes; a light source for irradiate toward an inner flat surface of said supporting member provided inside said casing; and a light receiving device for receiving a reflected light of the light irradiated from the light source.

(6) A touch signal probe according to claim 2, wherein said displacement detecting means is optical displacement detecting means which includes; a light source provided in a hollow portion which is spaced inside said supporting member; a roof plate for covering the hollow portion of said supporting member for transmitting the light irradiated from the light source; and a receiving plate disposed at predetermined intervals from the roof plate for receiving the light from the light source through the roof plate.

(7) A touch signal probe according to claim 1, wherein said means for decreasing the urging force includes; an inner circumferential surface having a different curvature from that of the outer circumf r ntial surface of said supporting member such as to have a cresc nt s ction; a m vable element abutting

against the inn r circumfer ntial surfac of said supporting member at one end portion of the movable element, the movable element being supported by said casing for moving into an axial direction thereof; and means for urging the movable element so as to that the one end portion of the movable element abuts against the inner circumferential surface of said supporting member, and wherein said displacement detecting means for detecting the attitude change of said supporting member is arranged so as to detect the axial movement of the movable element, so that when said stylus is placed at a reference position, a place at which the movable element abuts against the inner circumferential surface of said supporting member is the most distant place from the outer circumferential surface of said supporting member whereby the means for urging the movable element is deflected most, and when said stylus is fluctuated from the reference position owing to abutting against the object to be measured, a place at which the movable element abuts the inner circumferential surface of said supporting member is close to the outer circumferential surface of said supporting member.

(8) A touch signal probe according to claim 7, wherein the inner circumferential surface of said supporting member is formed into a circular shape of which radius is longer than that of the outer circumferential surface.

(9) A touch signal probe according to claim 7, wherein said displacement detecting means is optical displacement detecting m ans provid d with an optical fiber.

(10) A t uch signal probe according to claim 7, wherein said displacement detecting means is electrical displacement detecting means including a piezoelectric actuator.

(11) A touch signal probe according to claim 7, wherein said displacement detecting means is electrical displacement detecting means having a differential transformer.

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